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Art XVII.—*Ecological Studies in Victoria—Part V. Red Box-Red Stringybark Association.*

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The two trees, Red Box (*Eucalyptus polyanthemos*) and Red Stringybark (*E. macrorrhyncha*) occur together in many parts of the State, accompanied by the Long-leaved Box (*E. elaeophora*), but owing to the more conspicuous characters of the two former, their popular names have been united to designate this particular association. It is found on both sides of the Dividing Range, and extends into East Gippsland, but in the latter area it is not strongly developed although the individual species are fairly widespread. The three dominants are frequently associated with Red Ironbark (*E. Sideroxylon*) which, although it has a wide distribution, is more restricted than the other three. On the lower elevations of the northern slopes of the Dividing Range, Red Ironbark united with Grey Box (*E. hemiphloia*) and White Ironbark (*E. leucoxylon*) to form the Box-Ironbark forests, but quite commonly it forms a pure forest itself. Red Ironbark is therefore not considered to be a member of the Red Box-Red Stringybark Association, but when it occurs it indicates that conditions are becoming unfavorable for the development of this association. Another eucalypt, Yellow Box (*E. melliodora*) may also occasionally be present, but it also indicates a change in soil condition.

This association occurs freely on both palaeozoic sedimentary and igneous rocks in widely separated areas. The dominants are always characteristic, and judged by these alone, they form a definite forest type. However, the various occurrences of this association are so distributed and separated from one another that it may subsequently be found that the ground vegetation varies considerably. This is of some importance in view of Cajander's (2) theory of forest types in which the basis of classification of forest land is the plant association, but independent of the species of trees. Cajander says, "all those stands are referred to the same forest type the vegetation of which . . . is characterized by a more or less identical floristic composition . . . ."

Besides passing into the Box-Ironbark forest type, at other times this association passes gradually into grassland. There is always present in the ground flora a large number of grass species, and as the trees become wider and wider apart, so the grasses

become more and more dominant, and the other associated species gradually decrease. The forest passes into Savannah or Steppe.

The Red Box-Red Stringybark Association has only been intensively studied in the Greensborough-Diamond Creek area, but observations have been made from the Plenty River on the west to Warrandyte on the east, and northwards to Panton Hill. This area forms part of the Nillumbik Peneplain of Jutson (7) and Junner (6), by whom it has been very fully dealt with. Hills (5) considers that the Nillumbik Peneplain is best regarded as a modified pre-Older Basaltic Terrain which was of low relief. The area consists in the main of openly folded Silurian sediments, together with, on the higher levels, patches of Older Basalt and some gravels. Neither of these latter geological formations has been included in this study. The basalt areas have an entirely different soil and are intensively cultivated. The gravel deposits are very shallow, and have been largely removed for commercial purposes. After, or during, the extrusion of the Older Basalt (5), which is probably of Oligocene age, the land became partly depressed, and on it were laid the sands and gravels which constitute the coastal plain south-east of Melbourne, on which is developed the Cheltenham Flora (10). Depression continued until the Kalimnan period (Lower Pliocene), and then uplift occurred. Junner (6) considers the elevation was slow, and according to Hills (4) amounted to hundreds of feet only. These elevated areas are still lower than the pre-Older-Basaltic Divide.

A large proportion of the original forest has been replaced by orchards, the fruit grown being apples, pears, peaches, plums, and to some extent, lemons. The remaining area has been subject to human interference, chiefly confined, however, to the felling of the trees, which have again grown and formed forest. The soil has not been interfered with, and, apart from the periodic felling of the trees, the areas are practically left alone. Only occasionally are old trees met with, and these indicate the nature of the original forest. There is frequently a great difference between the degrees of development of the lower shrub stratum owing to the variation of density in the crown cover. Where the crowns meet in close canopy the vegetation is sparse, and this is also found on slopes facing the north.

Physiognomy.

The Red Box-Red Stringybark Association is characteristically xerophytic, and aptly fits the description by Schimper (16) of sclerophyllous forest. The trees are small, from 20 to 30 feet high, with short trunks and wide crowns which allow ample light to reach the forest floor. The leaves are coriaceous, and the trunks clothed with a thick persistent bark. All the three dominants have drooping leaves. Although there are several species of tall shrubs present, they occur very sparsely and do not affect the physiognomy. The under-shrubs are abundantly

present, both as regards individuals and species. These possess generally small leaves and narrow stems, as already seen in the Cheltenham Flora (10). The ericoid leaf is found in Leguminosae, Proteaceae, Compositae, and Epacridaceae. Between the shrubs are tufts of perennial grasses, which mostly elevate their inflorescences late in the spring or early summer. The shrubs and grasses together do not form a complete soil cover. Except at flowering time the grasses, although plentifully present, are not conspicuous. Both grasses and shrubs are markedly xerophytic.

Perhaps the most remarkable feature of the association is the large number of species present that perennate underground during the adverse period. This is, of course, particularly the case with Liliaceae and Orchidaceae, both of which are strongly represented. But besides these there are several other families, as Ranunculaceae, Droseraceae, Geraniaceae, and Compositae, that have swollen underground parts. Others, as *Helichrysum scorpioides* and species of *Erechthites,* arise from the underground part of the previous year's shoot.

Lianes are well represented, although they have only rather small shrubs for support. None of these ascend the dominant trees. As with the other growth-forms, the lianes belong to widely differing families, as Liliaceae, Ranunculaceae, Droseraceae, Pittosporaceae, Leguminosae, and Polygalaceae.

In Table I. are given the numbers and percentages of each life form occurring in the Red Box-Red Stringybark Association. The life forms are based upon the system of Raunkaier (15), and modified by Braun Blanquet (1). The life forms of Parasites and Lianes have been added. Macrophanerophytes are those plants with growing points above 2 metres from the ground, Nanophanerophytes from 0.25 metres to 2 metres, Chamaetophytes with buds on surface of ground or up to 0.25 metres. Hemicryptophytes have dormant buds in the surface of soil. Geophytes perennate wholly below ground. Therophytes are annuals.

TABLE I.—CLASSIFICATION OF THE LIFE FORMS OF THE RED BOX-RED STRINGYBARK ASSOCIATION.

Life form.	Number.	Percentage.
		%
Macrophanerophytes	9	5.7
Nanophanerophytes	19	11.9
Chamaetophytes	24	15.0
Hemicryptophytes	33	20.6
Geophytes	57	35.6
Therophytes	10	6.2
Lianes	5	3.1
Parasites	3	1.9
Total	160	100.0

As Geophytes do not affect the physiognomy but chiefly only the spring aspect of the association, in such a classification, therefore, undue importance is given to them, and this is due in a great measure to the large number of species of both Orchidaceae and Liliaceae. The classes Chamaetophyte and Hemicryptophyte are frequently very difficult to determine.

Composition.

The association is characterized by the richness of its flora in families, genera, and species (Table IV.). There is a strong representation of characteristic Australian genera, but an outstanding exception is *Casuarina*. Over a wide area, only a single specimen of *Casuarina suberosa*, and one of *C. stricta* have been seen, and they are therefore not regarded as members of this association.

The family Myrtaceae is only represented by the dominants of the association, all being species of *Eucalyptus*. These five species (Table IV.) belong to four sections of the genus, and therefore cannot be regarded as being intimately related to one another. This lack of close relationship between species of a genus found in any particular association appears to be a characteristic feature. In other associations dominated by species of Eucalyptus, as Box-Ironbark (*E. hemiphloia, E. Sideroxylon*), and Messmate-Peppermint (*E. obliqua, E. australiana*), this lack of intimate relationship is again shown, for all these species belong to different sections of the genus. Even species that have the same growth-form may exhibit other marked differences. Thus the three species of *Drosera*, which are all Geophytes, represent three types of aerial growth. *Drosera Whittakeri* forms only a rosette, and the flower stalks are devoid of leaves, *D. auriculata* has an erect flowering shoot with auriculate stem leaves, while *D. Menziesii* is a climbing plant with rounded peltate leaves on the stem. *D. peltata*, which is very similar to *D. auriculata*, has not been found in this association, but does occur in the adjoining Messmate-Peppermint Association. The three commonly occurring species of *Helichrysum* also differ from one another very materially, and cannot be considered to be closely related in any way. *H. scorpioides* perennates below ground, and its basal leaves are large and mesophyllous. The flowering stalk is terminated by a large yellow head. *H. semipapposum* is semi-herbaceous, with fairly long, linear, woolly leaves, and the capitula are moderately small and crowded together. *H. obcordatum* is shrubby, with small leaves glabrous above, and very small crowded capitula. The fourth species, *H. apiculatum*, is rare, but it is very distinct from the others. Similar striking differences may be seen between species of *Acacia, Pultenaea, Viola*, and *Brachycome*.

This frequent lack of intimate relationship between species of a genus is paralleled by the lack of close relationship that exists generally between the species of any association, due to the fact that they belong to widely differing genera and families. It has been previously indicated (11) that it is usual for a large number of genera to be represented by a single species, and, therefore, the average number of species per genus for any association is small. In this particular association there are no less than 80 such genera. Some of these are very large, and are prominent in Australian vegetation. Of the fifteen largest genera in Victoria (12), four of them—*Prasophyllum, Grevillea, Goodenia,* and *Leucopogon*—are represented here by a single species. Among the fifteen largest genera in the Commonwealth (12) *Prasophyllum* does not occur, but *Stylidium* is included, and has in this association a single species. There are only two genera, *Olearia* and *Carex,* which occur among the fifteen largest genera in Victoria which are not represented.

The family Orchidaceae is, among other features, remarkable in this association for the number of genera and species (Table IV.), and the extraordinarily large numbers of individuals present. Three genera, *Pterostylis, Prasophyllum,* and *Caladenia,* occur among the fifteen largest genera in Victoria, and all are represented here. The family Orchidaceae occurs among the ten largest families in both Victoria and the Commonwealth. The species are only above ground during the period of the year when soil moisture is abundant, from late autumn to late spring. The only exception is *Dipodium punctatum,* which is saprophytic, and which flowers during the hottest period of the year. This orchid is also the largest, with the possible exception of *Thelymitra grandiflora.* Some species of Orchidaceae are exceedingly gregarious, in particular *Corysanthes diemenica* and *Cyrtostylis reniformis.* Both of these form small societies to the exclusion of other species, and both tend to occur at the bases of large trees. A remarkable feature of these societies is that very few of the individuals produce flowers, which is in strong contrast with the free flowering of such scattered species as *Microtis porrifolia* and *Glossodia major.*

The genus *Pterostylis* is represented by the largest number of species, and probably also produces the greatest number of individuals, which may be locally abundant as *P. nutans,* or somewhat isolated as *P. longifolia.* The members of the genus may conveniently be divided into two groups, those with and those without a rosette. Those with a rosette exhibit a remarkable degree of variation within very narrow limits of certain characters. *P. parviflora* flowers soon after the autumn rains and before the appearance of the rosette, which is produced on another shoot towards the close, or soon after flowering. The

flowering shoot draws upon the reserve food material produced during the previous year. Before winter appears the rosette of *P. nutans* which flowers during the winter. This species has a remarkably long flowering period. Similar to *P. nutans* in producing the rosette before flowering and retaining it until after flowering are *P. curta, P. nana,* and *P. pedunculata.* The rosettes of these species begin to wither during September. The last to bloom is *P. pusilla,* which produces its first flowers during October, when its rosette has already withered. In this latter case the production and withering of the rosette precede the flowering period.

In *Caladenia* the species present are all similar vegetatively in having a single, linear to linear-lanceolate, basal leaf, and in having a small bract along the usually singly terminated flowering stem, but they differ appreciably from one another in the form and colour of their flowers. *C. carnea* is pink, while *C. coerulea* is blue. In *C. dilatata,* which is very common, there is an extravagant development in the length of the perianth parts except the labellum, which is much fringed. There is no close relationship between the two former species and *C. dilatata,* but this latter is closely connected with *C. cardiochila,* which is very rare. Closely related to these two, and differing but slightly from them, is *C. Patersonii,* which has not been found by the author in the Red Box-Red Stringybark Association, but which is abundant in the adjoining Messmate-Peppermint Association. It may be here noted that the recognition of such closely allied forms as *C. dilatata, C. cardiochila,* and *C. Patersonii* as separate species is frequently the cause of disagreement among systematists. Of these three, Mueller (9) recognized *C. Patersonii* only. Similarly, of the two closely allied, *C. testacea* and *C. carnea,* Mueller only recognized the latter.

The species of *Acacia* occurring in the Red Box-Red Stringybark Association are very distinctive, and are different from those occurring in other Victorian Associations, in which there is comparatively little overlap in regard to species. In Table II. are given the species of *Acacia* in various associations, together with the sections of the genus to which they belong.

In Table II. it will be noted that all the *Acacias* in the Red Box-Red Stringybark Association belong to the same section of the genus, but they are nevertheless very distinctive. Although the genus *Acacia* is a very large (Table III.) and widely distributed one, yet its representation in each of the associations given is not large. This is also shown to be the case (Table III.) with other widespread genera which are represented in the Red Box-Red Stringybark Association. The number of species in the genus is taken from Willis (17), and the number in Victoria from Ewart (3).

TABLE II.—DISTRIBUTION OF SPECIES OF ACACIA IN VARIOUS ASSOCIATIONS.

Section of Genus.	Cheltenham Flora.	Coastal Dunes.	Fern Gully.	Red Box-Red Stringybark.	Messmate. Peppermint.
Uninerves	*armata*	..	..	*armata*	..
	..	..	..	*acinacea*	..
	..	..	..	*diffusa*	..
	..	..	..	*juniperina*	..
	..	..	..	..	*leprosa*
	..	..	..	..	*myrtifolia*
	..	..	..	..	*stricta*
	suaveolens	..	..	..	..
	..	..	..	*vomeriformis*	..
Plurinerves	..	..	*melanoxylon*	..	*melanoxylon*
Juliflorae	..	..	..	..	*longissima*
	Oxycedrus	..	..	..	..
	..	*Sophorae*	..	..	..
	..	..	..	..	*verticillata*
Bipinnatae	..	..	*dealbata*	..	*dealbata*

TABLE III.—NUMBER OF SPECIES OF SOME WIDESPREAD GENERA IN VARIOUS ASSOCIATIONS.

Genus.	Number of Species in—						
	Genus.	Victoria.	Cheltenham.	Coastal Dunes.	Fern Gully.	Basalt.	Red Box Red Stringybark.
Acacia ..	500	77	3	1	2	0	5
Helichrysum	350	23	2	1	..	1	4
Leucopogon ..	130	18	1	1	..	..	1
Stipa ..	120	18	1	..	..	3	2
Goodenia ..	100	19	1	..	..	1	1
Pimelea ..	80	22	3	..	..	3	2
Lepidosperma	40	16	1	1	1	..	1

From the above table it will be seen that there is a closer agreement between the Cheltenham Flora and the Red Box-Red Stringybark Association as regards the distribution of the genera than between any of the other associations.

TABLE IV.—COMPOSITION OF FLORA OF RED BOX-RED STRINGYBARK ASSOCIATION.

RED BOX–RED STRINGYBARK ASSOCIATION.

PTERIDOPHYTA

POLYPODIACEAE

Cheilanthes tenuifolia

SPERMATOPHYTA

ANGIOSPERMAE

MONOCOTYLEDONAE

GRAMINEAE

Agropyrum scabrum
Calamagrostis filiformis
C. quadriseta
Chloris truncata
Danthonia pallida
D. penicillata
D. semiannularis
Dichelachne crinita
D. sciurea
Poa caespitosa
Stipa mollis
S. pubescens
Themeda triandra

CYPERACEAE

Gahnia radula
Lepidosperma filiforme

JUNCACEAE

Luzula campestris

LILIACEAE

Anguillaria dioica
Bulbine bulbosa
B. semibarbata
Burchardia umbellata
Chamaescilla corymbosa
Dianella revoluta
Dichopogon strictus
Lomandra filiformis
L. longifolia
Thysanotus Patersonii
Tricoryne elatior
Xanthorrhoea minor

AMARYLLIDACEAE

Hypoxis glabella
H. pusilla

ORCHIDACEAE

Acianthus exsertus
Caladenia cardiochila
C. carnea
C. coerulea
C. dilatata
C. testacea
Calochilus Robertsonii
Corysanthes diemenica
Cyrtostylis reniformis
Dipodium punctatum
Diuris longifolia
D. maculata
D. pedunculata

ORCHIDACEAE—*continued.*
D. sulphurea
Eriochilus cucullatus
Glossodia major
Microtis porrifolia
Prasophyllum nigricans
Pterostylis alata
P. barbata
P. curta
P. longifolia
P. nana
P. nutans
P. parviflora
P. pedunculata
P. pusilla
P. revoluta
Thelymitra aristata
T. antennifera
T. carnea
T. ixioides
T. grandiflora

ARCHICHLAMYDEAE

PROTEACEAE
Grevillea rosmarinifolia

SANTALACEAE
Exocarpus cupressiformis

LORANTHACEAE
Loranthus pendulus

RANUNCULACEAE
Clematis microphylla
Ranunculus lappaceus

LAURACEAE
Cassytha glabella

DROSERACEAE
Drosera auriculata
D. Menziesii
D. Whittakeri

CRASSULACEAE
Crassula Sieberiana

PITTOSPORACEAE
Billardiera scandens
Bursaria spinosa

LEGUMINOSAE
Acacia acinacea
A. armata
A. diffusa
A. juniperina
A. vomeriformis
Bossiaea prostrata
Daviesia corymbosa
Dillwynia cinerascens
D. floribunda
Glycine clandestina
Hardenbergia monophylla
Hovea heterophylla
Indigofera australis
Kennedya prostrata
Platylobium obtusangulum
Pultenaea pedunculata
P. Gunnii

ROSACEAE
Acaena ovina
GERANIACEAE
Geranium pilosum
OXALIDACEAE
Oxalis corniculata
LINACEAE
Linum marginale
RUTACEAE
Correa rubra var. *virens*
POLYGALACEAE
Bredemeyera volubile
EUPHORBIACEAE
Poranthera microphylla
TREMANDRACEAE
Tetratheca ciliata
STACKHOUSIACEAE
Stackhousia monogyna
GUTTIFERAE
Hypericum gramineum
VIOLACEAE
Viola betonicifolia
V. hederacea
THYMELAEACEAE
Pimelea curviflora
P. humilis
MYRTACEAE
Eucalyptus elaeophora
E. macrorrhyncha
E. melliodora
E. polyanthemos
E. Sideroxylon
HALORRHAGIDACEAE
Halorrhagis tetragyna
UMBELLIFERAE
Daucus glochidiatus
Hydrocotyle laxiflora
H. medicaginoides

METACHLAMYDEAE
EPACRIDACEAE
Astroloma humifusum
Acrotriche serrulata
Epacris impressa
Leucopogon virgatus
Lissanthe strigosa
LOGANIACEAE
Mitrasacme paradoxa
GENTIANACEAE
Erythraea spicata
Sebaea ovata
CONVOLVULACEAE
Dichondra repens
BORAGINACEAE
Cynoglossum suaveolens
LABIATAE
Ajuga australis

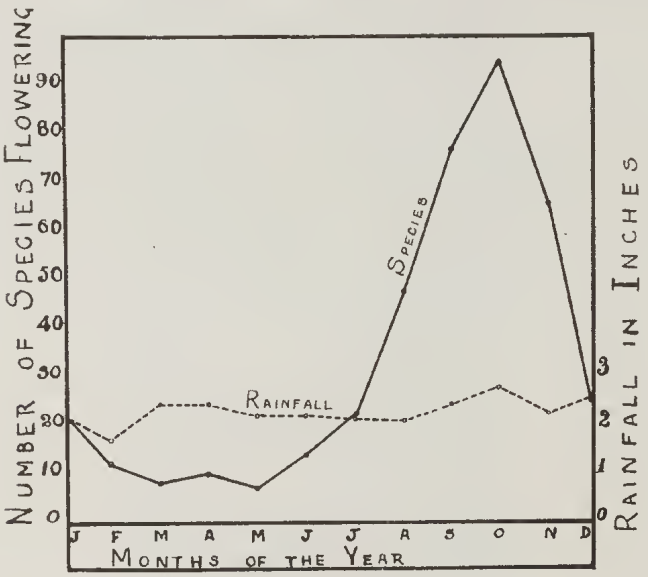
SCROPHULARIACEAE
Veronica gracilis
V. calycina
PLANTAGINACEAE
Plantago varia
RUBIACEAE
Asperula scoparia
CAMPANULACEAE
Lobelia gibbosa
Wahlenbergia gracilis
GOODENIACEAE
Goodenia geniculata
BRUNONIACEAE
Brunonia australis
STYLIDIACEAE
Stylidium graminifolium
COMPOSITAE
Brachycome decipiens
B. multifida
B. scapigera
Cassinia aculeata
C. longifolia
Craspedia uniflora
Cymbonotus Lawsonianus
Erechthites arguta
E. quadridentata
E. prenanthoides
Gnaphalium japonicum
Helichrysum apiculatum
H. obcordatum
H. scorpioides
H. semipapposum
Helipterum albicans
H. australe
Leptorhynchus squamatus
L. tenuifolius
Microseris scapigera
Millotia tenuifolia
Podolepis acuminata
Rutidosis leptorhynchoides
Vittadinia triloba

Environment.

(*a*) *Climate.*

The area between Greensborough and Diamond Creek lies within the railway suburban area of Melbourne, as do also Cheltenham and St. Albans. There is but little difference between the general climatic conditions of these three areas, and therefore no discussion of climatic factors other than given by Patton (10) and (11) need be mentioned. In Figure 1. are given the numbers of species flowering each month, and also the rainfall for Greensborough. It will be seen that the peak of flowering is in October, as was the case in the Cheltenham and in the Basalt Floras, and that there is a sudden fall from October to December. The soil steadily becomes drier through summer and autumn, and the

plants suffer a periodic drought. During the autumn of 1936, the moisture content sank to 2.8 per cent., but approximately 10 per cent. of moisture is required for germination of garden seeds. However, at this latter moisture content, germination is exceedingly slow. During the early period of the year, the limit



of endurance to drought is reached, and many plants may be seriously affected. In the present year, 1936, there was a very dry period, and *Epacris impressa* and *Astroloma humifusum* died extensively. In numerous plants of *Acacia diffusa* branches were dead. Although no plants of either *Correa rubra* var. *virens* or *Billardiera scandens* were found dead, both had the leaves much curled and were pale in colour. The severity of the dry period of 1936 was also indicated by the death of numerous forest trees between Fern Tree Gully and Ferny Creek. During the autumn of the years 1923, 1927, and 1932, plant life has suffered severely in various parts of the State from lack of moisture in the soil. The actual and average rainfall for the summer and autumn months for Melbourne is given for the years 1923, 1927, and 1936, in Table V. During February, 1932, there was widespread destruction of plant life on the northern end of the Buffalo Plateau, and this was followed by a severe bushfire.

It has previously been pointed out (13) that such periodically recurring dry periods must have an important effect on vegetation. A slight decrease in the annual average rainfall would eliminate a number of species, for undoubtedly several are at the limit of endurance. On the other hand, if there was an increase in the annual rainfall, such species as *Pteridium aquilinum* and *Acacia*

TABLE V.—MONTHLY RAINFALL FOR MELBOURNE FOR CERTAIN DRY YEARS COMPARED WITH AVERAGE.

Month.	Actual Rainfall Points.			Average Points.
	1923.	1927.	1936.	
January	99	60	130	186
February	61	75	58	175
March	33	134	52	226
April	..	57	430	220

myrtifolia, which at present occur where this association passes into Messmate-Peppermint, would gain entrance. The essential environmental factor which separates these two associations appears to be annual rainfall.

(*b*) *Soil.*

The controlling factor of the vegetation of this area as compared with that of the Tertiary Sands and Basalt areas is the geological formation. The bedrock outcrops at the surface in places, but generally it produces a shallow clayey soil which may contain a very large proportion of small stones. Soil may be defined ecologically as the medium in which roots find themselves. Lundergardh (8) defines soil as that part of the earth's crust that is clothed with plants. Both definitions include mud on a lake floor or the joint planes of a rock mass, and are widely different from the agricultural viewpoint, which conceives of a certain depth of material consisting of particles of a fineness less than 2 mm. diameter. This latter conception fails entirely to meet the needs of the ecologist. Several samples of the soil from the Red Box–Red Stringybark Association have shown that the particles above 2 mm. form more than 50 per cent. of the mass. Such large particles are important in the mechanical composition of the root environment. The soil varies so much that it is useless to give any profile of it. At times a feeble profile is developed, but is never pronounced, as in the Cheltenham Flora (10), or in the Basalt (11).

Although the area on which the Red Box–Red Stringybark is hilly, the total elevation is small, amounting to a few hundred feet only, at the highest point, and therefore insufficient to make any marked difference in the climatic conditions. Since the rainfall is similar to that of the other associations in the metropolitan area, the differences between the three major associations cannot be ascribed to this factor.

Discussion.

Within the area of the Nillumbik Peneplain there are patches of Older Basalt and of Gravels. This latter has been mostly removed, and therefore the vegetation has been disturbed. The soil of the Basalt is dark in colour, and is entirely different from

the creamy yellowish clay of the Silurian sediments. It has been devoted to entirely different agricultural pursuits. Yet both the Basalt and the Silurian sediments are at similar elevations, and have been subject to the same climatic conditions. The older Basalt is of Oligocene age, and therefore there has been abundant time for climate to produce similar soils on both the Basalt and the Silurian if climate be the cause of soil differences (14).

The three major geological formations in the metropolitan area, Silurian, Tertiary Coastal Plains, and the Newer Basalt (Pleistocene) have all been exposed to the same climatic conditions for long periods of time, much longer than the time interval for the development of the soil types in Russia, yet each has an entirely different soil. Climate, therefore, cannot be regarded as the factor which has produced such differing types. All three soils, although so different and clothed with very different types of vegetation, are classed together as podzolised soils on a map by Prescott (14). All three have much the same elevation, and therefore this factor cannot be considered to have produced the conspicuous differences. The only outstanding difference in the three areas is the geological formation, and to this factor alone must be ascribed the cause for the occurrence of three such striking plant associations, Grassland, Heath, and Sclerophyll Forest in close proximity to one another. Climate can only break down the rock mass, and cannot influence the final result over wide areas. Climate cannot determine the size of the soil particles, as is shown in the large proportion of sand in the soil derived from the ferruginous sandstones of the Tertiary Plains, or in the large proportion of clay in the soil derived from the Basalt. One cannot conceive of anything but a sandy soil being derived from a sandstone, and of this there are some striking examples in Australia. Nor can one conceive of any plant nutrients being added by climate. The soil resulting from any particular rock can only contain those elements which the disintegrated rock provides. Each of these associations, then, Sclerophyll Forest, Heath, and Grassland, owe their development to the type of rock underlying the area on which they grow.

The differences in the physiognomy of these associations is due to the life forms dominant in each case. Life form is an expression of the relation of the species present to the environment, and a large number of families converge to the same life form. It has already been noted, for instance, that both Lianes and Geophytes are produced from widely differing families. Since particular life forms are found under particular environmental conditions, it may safely be concluded that such forms are particularly adapted to those conditions.

An association is notable for the low number of species per genus, the divergent nature of the families represented, and the domination of certain life forms. All of these three features

are interlocked. The total number of life forms in nature is surprisingly small, and therefore the divergent families must converge on the one life form favorable to the environment, if they are to be represented in any particular association.

It is not suggested that there is an active response on the part of the plant to the environment, but that, since variation is inherent in life itself, and, indeed, may be considered a characteristic equally with growth, appetite, reproduction, irritability, &c., the opportunity for a new variant to occur is when a new environment is presented. Species are natural units with well defined characters, as, for instance, those given in Table II., but if we assume that species are built up by accretions of small differences, then there should be a passage from one species to another in a genus. Or in other words, there should be in general a graduated series of species. This does occur at times, particularly in the genus *Eucalyptus*, as, for instance, in the Stringybark section. In the genus *Caladenia* also there are related species, but it may be reasonably argued that *C. dilatata*, *C. cardiochila*, and *C. Patersonii* are merely varieties and not distinct species. The variations that constitute these forms are no doubt heritable, but a heritable variation is insufficient for the establishment of a species.

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